CLAIMS

1. A method for determining model parameters associated with a sample, comprising operations of:

applying, to the sample, an excitation using a source, in which the excitation has at least a wavelength and an intensity or a flux, and in which the excitation comprises one of: electromagnetic radiation, a radio-frequency wave, a particle beam, a sound wave, a magnetic field, or an electric field;

measuring, using a measurement device, a response associated with the sample to the excitation;

computing, using the measured response and information specifying the excitation as inputs to a predetermined predictive model, the model parameters on a voxel-by-voxel basis in a forward model with multiple voxels that represent the sample, in which the forward model simulates response physics occurring within the sample to a given excitation with a given wavelength and a given intensity or a given flux, that are selected from a range of measurement conditions that includes the excitation, the wavelength and the intensity or the flux, and at least a different wavelength and at least a different intensity or a different flux, and

in which the forward model is a function of the excitation, the model parameters of the multiple voxels, and differential or phenomenological equations that approximates the response physics;

determining, using a computer, an accuracy of the model parameters by comparing at least the measured response and a calculated predicted value of the response using the forward model, the model parameters and the excitation;

providing, when the accuracy exceeds a predefined value, the model parameters as an output to a user, to another electronic device, to a display or to memory; and

when the accuracy is less than the predefined value, modifying the model parameters, and repeating the computing and the determining.

2. A method according to Claim 1, in which the predetermined predictive model comprises one of: a machine-learning model, or a neural network.

3. A method according to Claim 1, in which the predetermined predictive model comprises a personalized predictive model that corresponds to an individual.

4. A method according to Claim 1, in which, when the accuracy exceeds the predefined value, the model parameters are computed in a single pass without further iteration.

5. A method according to Claim 1, in which the model parameters having the accuracy exceeding the predefined value are computed using fewer iterations with the predetermined predictive model than an iterative measurement and analysis technique without the predetermined predictive model.

6. A method according to Claim 1, in which, when the accuracy is less than the predefined value, the method comprises:

calculating, using information specifying the excitation and the accuracy as inputs to a second predetermined predictive model, a revised excitation that has at least a revised wavelength, a revised intensity or a revised flux; and

repeating the applying, measuring, computing and determining operations with the revised excitation instead of the excitation.

7. A method according to Claim 6, in which the second predetermined predictive model comprises one of: a machine-learning model, or a neural network.

8. A method according to Claim 1, in which, when the accuracy is less than the predefined value, the method comprises:

adding the excitation and the measured response to a training dataset; and

determining, using the training dataset, a revised instance of the predetermined predictive model.

9. A method according to Claim 1, in which the method comprises classifying or segmenting one or more anatomical structures in the sample using the model parameters and a second predetermined predictive model.

10. A method according to Claim 9, in which the second predetermined predictive model comprises one of: a machine-learning model, or a neural network.

11. A method according to Claim 1, in which the method comprises training the predetermined predictive model using a simulated dataset computed using the forward model, a range of model parameters and a range of excitations.

12. A method according to Claim 1, in which the excitation is one of: an electromagnetic beam in an x-ray band of wavelengths, a neutron beam, an electron beam, an electromagnetic beam in an optical band of wavelengths, an electromagnetic beam in an infrared band of wavelengths, a sound wave in an ultrasound band of wavelengths, a proton beam, the electric field associated with an impedance measurement device, the radio-frequency wave associated with a magnetic-resonance apparatus, or the magnetic field associated with a susceptibility measurement device.

13. A method according to Claim 1, in which the measured response comprises a time-domain response of the sample and is other than an image.

14. A non-transitory computer-readable storage medium for use in conjunction with a computer, the computer-readable storage medium configured to store program instructions that, when executed by the computer, cause the computer to perform operations comprising:

applying, to a sample, an excitation using a source, in which the excitation has at least a wavelength and an intensity or a flux, and in which the excitation comprises one of: electromagnetic radiation, a radio-frequency wave, a particle beam, a sound wave, a magnetic field, or an electric field;

measuring, using a measurement device, a response associated with the sample to the excitation;

computing, using the measured response and information specifying the excitation as inputs to a predetermined predictive model, model parameters on a voxel-by-voxel basis in a forward model with multiple voxels that represent the sample, in which the forward model simulates response physics occurring within the sample to a given excitation with a given wavelength and a given intensity or a given flux, that are selected from a range of measurement conditions that includes the excitation, the wavelength and the intensity or the flux, and at least a different wavelength and at least a different intensity or a different flux, and

in which the forward model is a function of the excitation, the model parameters of the multiple voxels, and differential or phenomenological equations that approximates the response physics;

determining, using the computer, an accuracy of the model parameters by comparing at least the measured response and a calculated predicted value of the response using the forward model, the model parameters and the excitation;

providing, when the accuracy exceeds a predefined value, the model parameters as an output to a user, to another electronic device, to a display or to memory; and

when the accuracy is less than the predefined value, modifying the model parameters, and repeating the computing and the determining.

15. A non-transitory computer-readable storage medium according to Claim 14, in which the predetermined predictive model comprises one of: a machine-learning model, or a neural network.

16. A non-transitory computer-readable storage medium according to Claim 14, in which, when the accuracy exceeds the predefined value, the model parameters are computed in a single pass without further iteration.

17. A non-transitory computer-readable storage medium according to Claim 14, in which, when the accuracy is less than the predefined value, the operations comprise:

calculating, using information specifying the excitation and the accuracy as inputs to a second predetermined predictive model, a revised excitation that has at least a revised wavelength, a revised intensity or a revised flux; and

repeating the applying, measuring, computing and determining operations with the revised excitation instead of the excitation.

18. A non-transitory computer-readable storage medium according to Claim 17, in which the second predetermined predictive model comprises one of: a machine-learning model, or a neural network.

19. A system configured to determine model parameters, comprising:

a source configured to provide an excitation, in which the excitation comprises at least one of: an electromagnetic beam in an x-ray band of wavelengths, a neutron beam, an

electron beam, an electromagnetic beam in an optical band of wavelengths, an electromagnetic beam in an infrared band of wavelengths, a sound wave in an ultrasound band of wavelengths, a proton beam, an electric field associated with an impedance measurement device, a radio-frequency wave associated with a magnetic-resonance apparatus, or a magnetic field associated with a susceptibility measurement device;

a measurement device configured to perform measurements, in which the measurement device comprises at least one of: an x-ray detector, a neutron detector, an electron detector, an optical detector, an infrared detector, an ultrasound detector, a proton detector, the magnetic-resonance apparatus, the impedance measurement device or the susceptibility measurement device;

a processor, coupled to the source, the measurement device and memory, configured to execute program instructions; and

the memory, coupled to the processor, configured to store the program instructions that, when executed by the processor, cause the system to perform operations comprising:

applying, to a sample, the excitation using the source, in which the excitation has at least a wavelength and an intensity or a flux, and in which the excitation comprises one of: electromagnetic radiation, a radio-frequency wave, a particle beam, a sound wave, a magnetic field, or an electric field;

measuring, using a measurement device, a response associated with the sample to the excitation;

computing, using the measured response and information specifying the excitation as inputs to a predetermined predictive model, model parameters on a voxel-by-voxel basis in a forward model with multiple voxels that represent the sample, in which the forward model simulates response physics occurring within the sample to a given excitation with a given wavelength and a given intensity or a given flux, that are selected from a range of measurement conditions that includes the excitation, the wavelength and the intensity or the flux, and at least a different wavelength and at least a different intensity or a different flux, and

in which the forward model is a function of the excitation, the model parameters of the multiple voxels, and differential or phenomenological equations that approximates the response physics;

determining, using the processor, an accuracy of the model parameters by comparing at least the measured response and a calculated predicted value of the response using the forward model, the model parameters and the excitation;

providing, when the accuracy exceeds a predefined value, the model parameters as an output to a user, to another electronic device, to a display or to the memory; and

when the accuracy is less than the predefined value, modifying the model parameters, and repeating the computing and the determining.

20. A system according to Claim 19, in which the predetermined predictive model comprises one of: a machine-learning model, or a neural network.